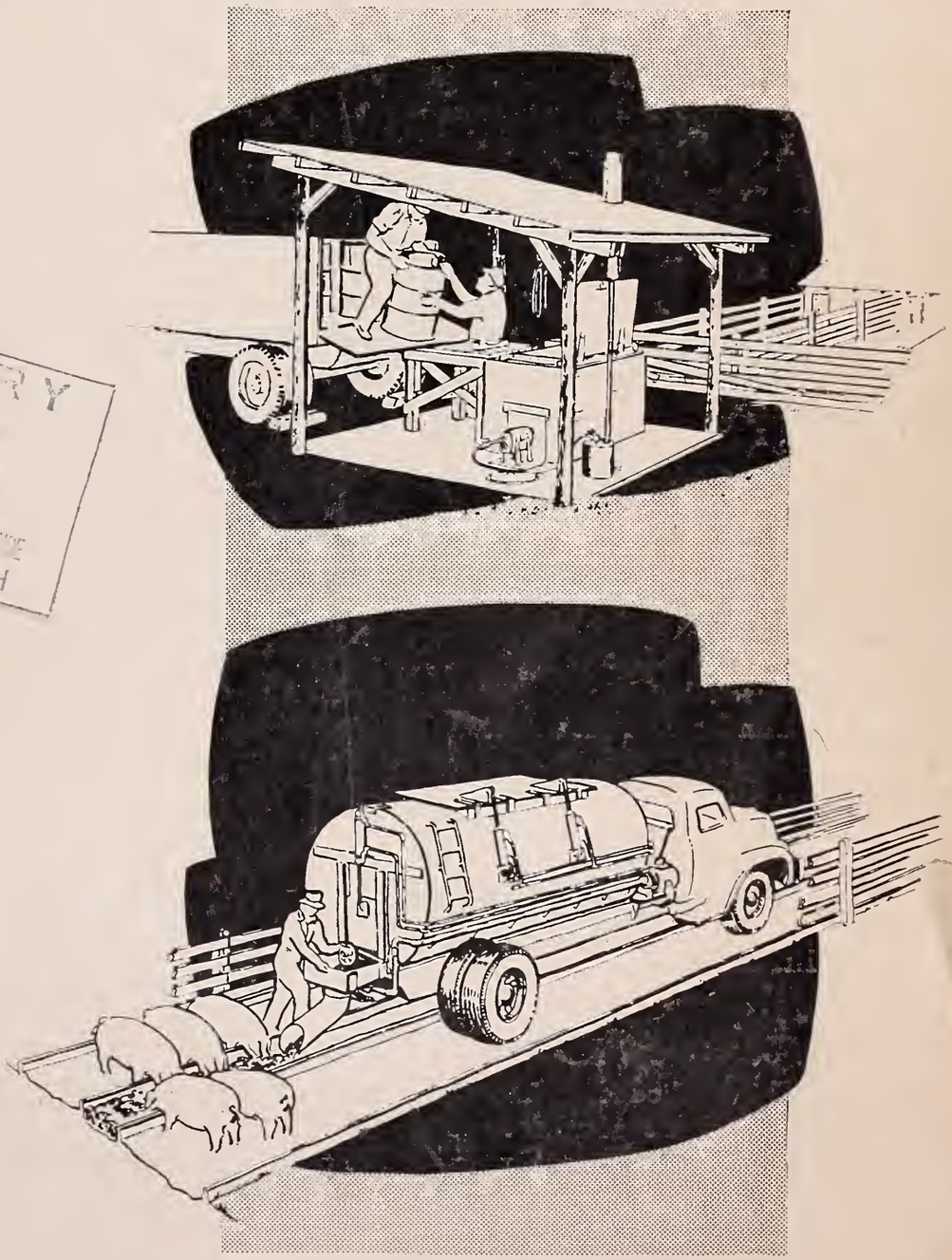
Equipment and methods for
HEAT-TREATING GARBAGE
FOR HOG FEED



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CONTENTS

This publication is intended to serve as a guide to hog feeders and others on the effective use and care of equipment for heat-treating garbage to be used as hog feed. It is based largely on information obtained by the author during visits to garbage-feeding premises throughout the country.

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EQUIPMENT AND METHODS FOR HEAT-TREATING GARBAGE

FOR HOG FEED

By Paul E. James, Mechanical Engineer, *Animal Disease Eradication Division, Agricultural Research Service*

Many cities have found the use of garbage as swine feed to be the most practical and efficient method of disposal. More than 2 million swine are raised on garbage in the United States each year—more than the total number of hogs raised in many countries.

This widespread use of garbage as swine feed presents a problem in disease prevention. Raw garbage may contain infected meat scraps. When eaten by swine, this infected meat can be the means of introducing and spreading many diseases. In turn, infected swine can spread disease to other livestock and sometimes to man. Trichinosis, a parasitic disease of man, has been spread and perpetuated in the United States largely through the feeding of raw garbage to swine. Human beings contract the disease by eating infected pork that has not been cooked properly.

Animal diseases that can be spread by infected meat fed in raw garbage include vesicular exanthema, hog cholera, avian and bovine tuberculosis, erysipelas, foot-and-mouth disease, and some of the Salmonella infections.

Approximately 1 million hogs became infected with or were exposed to vesicular exanthema from June 1952 through December 1956, largely through infected meat scraps fed in raw garbage. It was apparent early in the outbreak that eradication of the disease was imperative to protect the swine industry. In 1952 the Secretary of Agriculture declared a state of emergency arising from the existence of the disease, and an active program of eradication was started. This program consisted of the following measures:

1. Inspection.
2. Prompt disposal of infected and exposed swine.
3. Cleaning and disinfection of infected premises.
4. Control over the marketing of garbage-fed swine.
5. Heat-treatment of garbage for use as swine feed.

All five measures are essential for eradication of vesicular exanthema. Attempts to eradicate the disease without enforcing all five measures have proved unsuccessful.

BENEFITS OF HEAT TREATMENT

Heat treatment of garbage is a significant economic factor in disease eradication. In addition to reducing the heavy direct and indirect costs of livestock diseases in this country, feeding of heat-treated garbage affects the world market for our pork. If hog cholera and vesicular exanthema could be eliminated in the United States, our exports to countries that now restrict our pork because of these diseases could be increased by an estimated 66 million pounds annually. For example, in Canada a national law requires heat treatment of garbage to aid in the control and eradication of hog cholera and prohibits imports of pork from hogs fed raw garbage. England has similar requirements to prevent the introduction and spread of foot-and-mouth disease.

Although the primary purpose of heat-treating garbage is the control or reduction of swine diseases, many other benefits are derived from the heat treatment. Among these are the following:

1. Hogs will eat more heat-treated garbage than raw garbage. Such items as potatoes, onions, turnips, and citrus rinds—unpalatable when raw—are readily eaten when properly heat treated. Also, research has shown that properly heat-treated garbage is as nutritious as raw garbage, if it is cooled quickly and if the juices are conserved. Feeding in troughs retains the liquids, which may contain vitamins.

2. Studies in Massachusetts indicate that feeding heat-treated garbage may require less labor than feeding raw garbage because less cleaning is required after feeding.

3. Heating distributes the food value throughout the garbage and thus produces a more uniform feed. This results in more uniform, faster gains, or more pork per ton of garbage. Small pigs cannot be crowded away from the more nutritious parts of the garbage, as may happen when raw garbage is fed.

4. If the initial feeding of heat-treated garbage is carefully regulated, feeder pigs can be "started" at 40 pounds.

5. Reports from California indicate that the increased financial return obtained from hogs fed heat-treated garbage more than pays for the cost of the heat treatment.

6. There is less residue after feeding heat-treated garbage; hence, less decomposition. As a result, heat-treated garbage attracts fewer flies than raw garbage and has a less objectionable odor.

7. The residue from garbage fed to hogs is frequently spread on fields as fertilizer. Thus, heat-treatment can help to prevent the spread of plant diseases that may be present in raw (untreated) garbage.

Because of the importance of heat-treating garbage for use as hog feed, 47 States now have laws or regulations requiring the practice. All are based on the requirement that garbage to be used for animal feed should be heated at least to boiling temperature (212° F.) and held at that temperature at least 30 minutes.

EQUIPMENT

Many types of garbage-heating equipment have been designed since the outbreak of vesicular exanthema in 1952. Some of this equipment is excellent, some is good, and some is wholly impractical. Two types have proved successful: (1) Direct-fire equipment (for small-scale operations) and (2) steam-injection equipment (for large-scale operations).

For information on where to obtain equipment, consult your county agent, State veterinarian, or local machinery dealer.

Direct-fire Equipment

The direct-fire method of heating garbage usually is used for loads under 300 gallons. Equipment may be either factory made or constructed on the farm.

Farm-made direct-fire equipment is generally stationary and consists of a rectangular or cylindrical vat enclosed in a firebox (fig. 1). The garbage is heated by a flame in direct contact with the vat.

Figure 2 shows plans for efficient direct-fire equipment.

Although solid fuel (coal, wood, old rubber tires) is sometimes used as the source of heat, kerosene or oil is more satisfactory. Gasoline should not be used; it is too explosive to use in a confined firebox. Figure 3 shows plans for an inexpensive gravity-feed burner that uses kerosene or oil as fuel.

If solid fuel is used, the ashes should be cleaned daily (fig. 4). Garbage in the center of the load will not heat properly if there is an accumulation of ashes in the firebox.

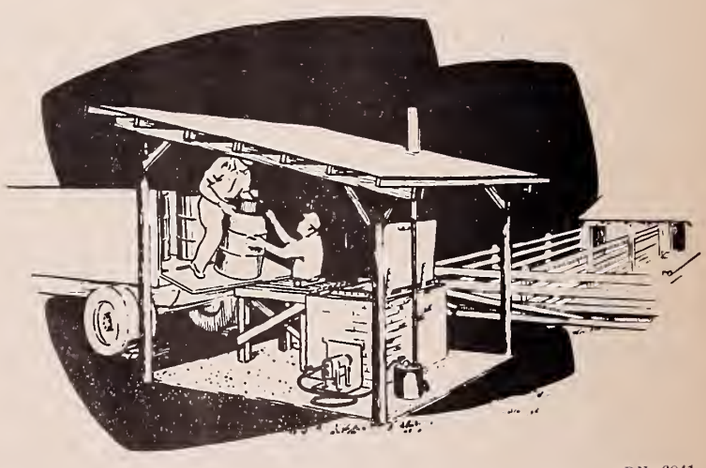

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Figure 1.—Stationary equipment.

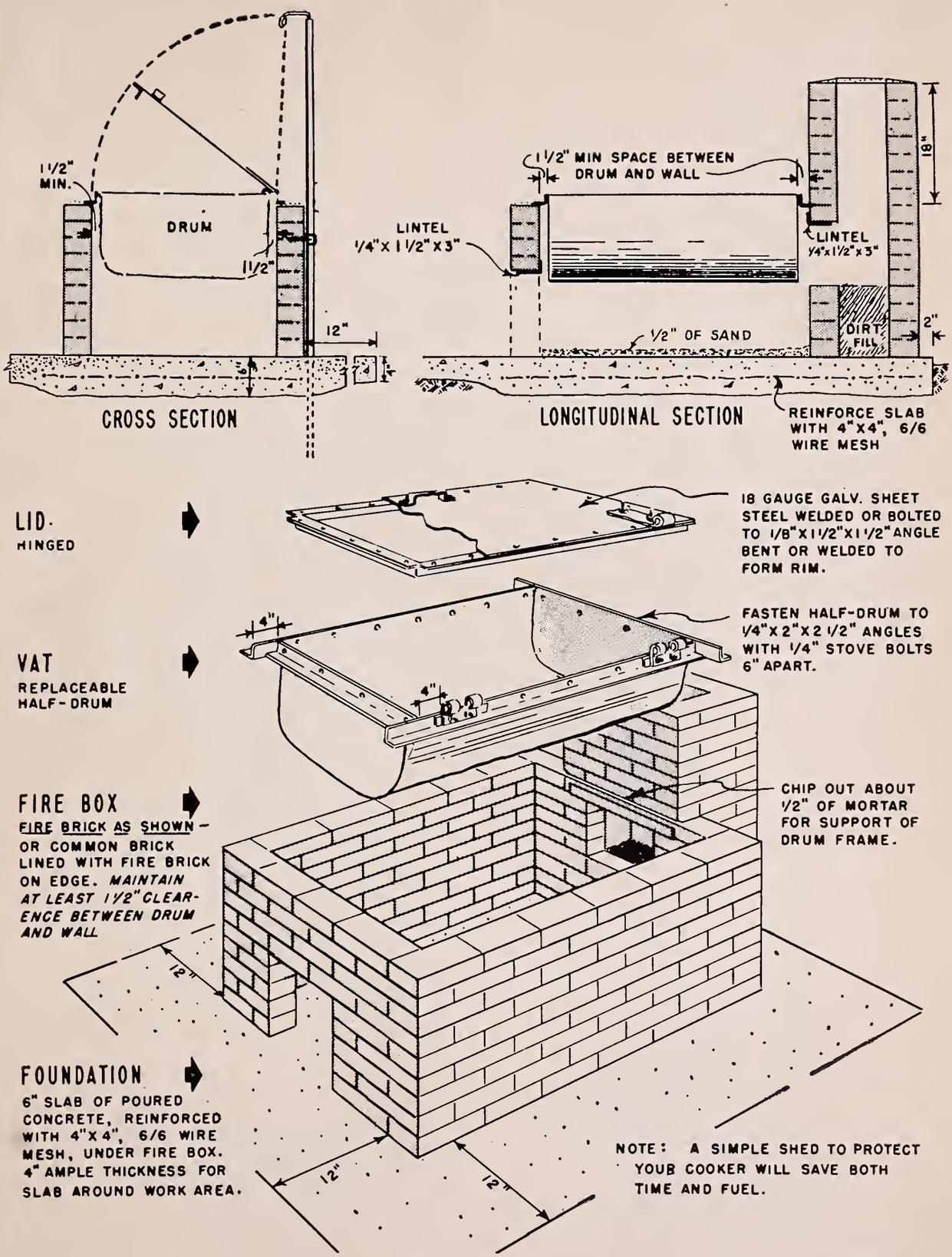

Figure 2.—Plans for efficient direct-fire equipment.

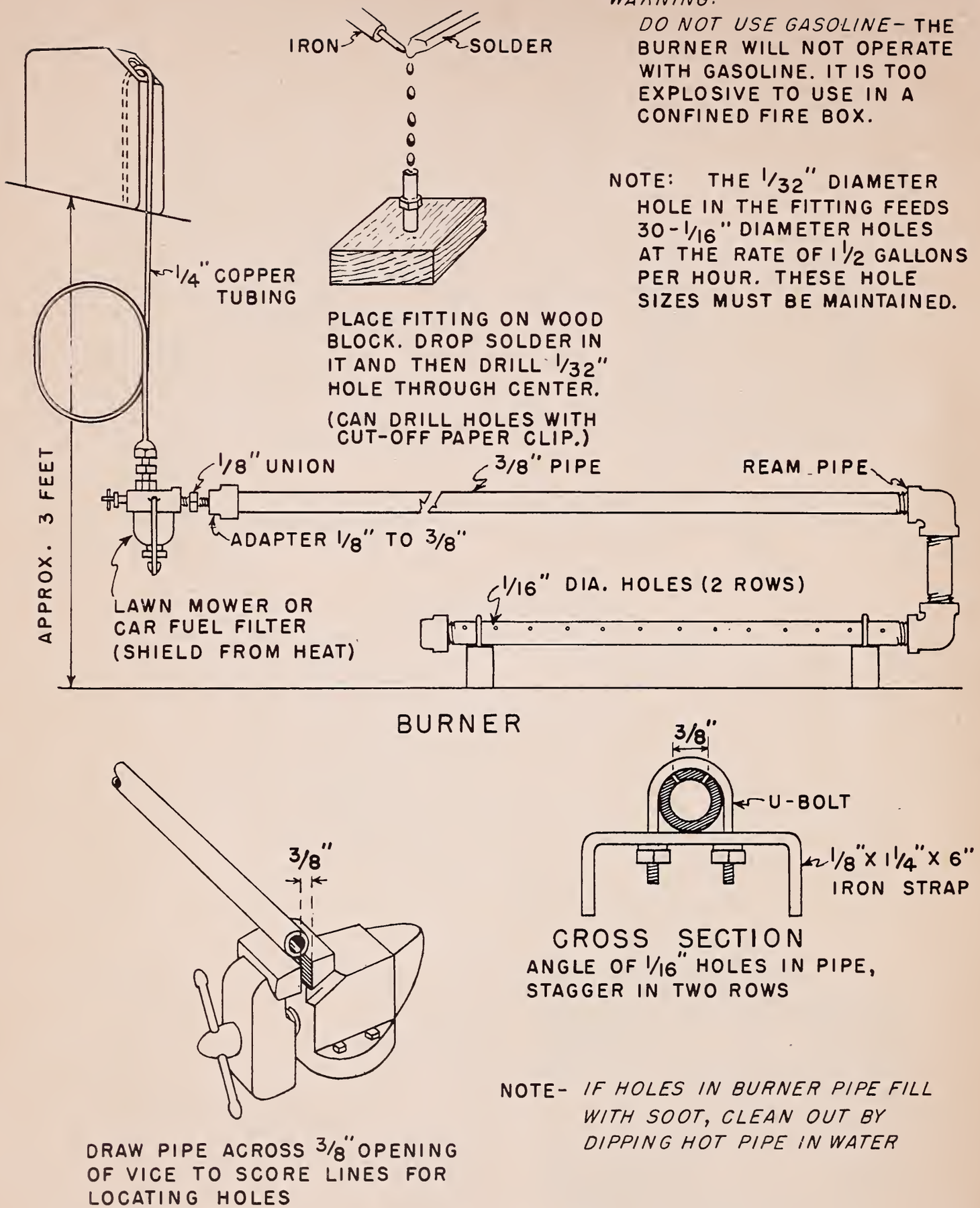

Figure 3.—Gravity-feed oil burner.

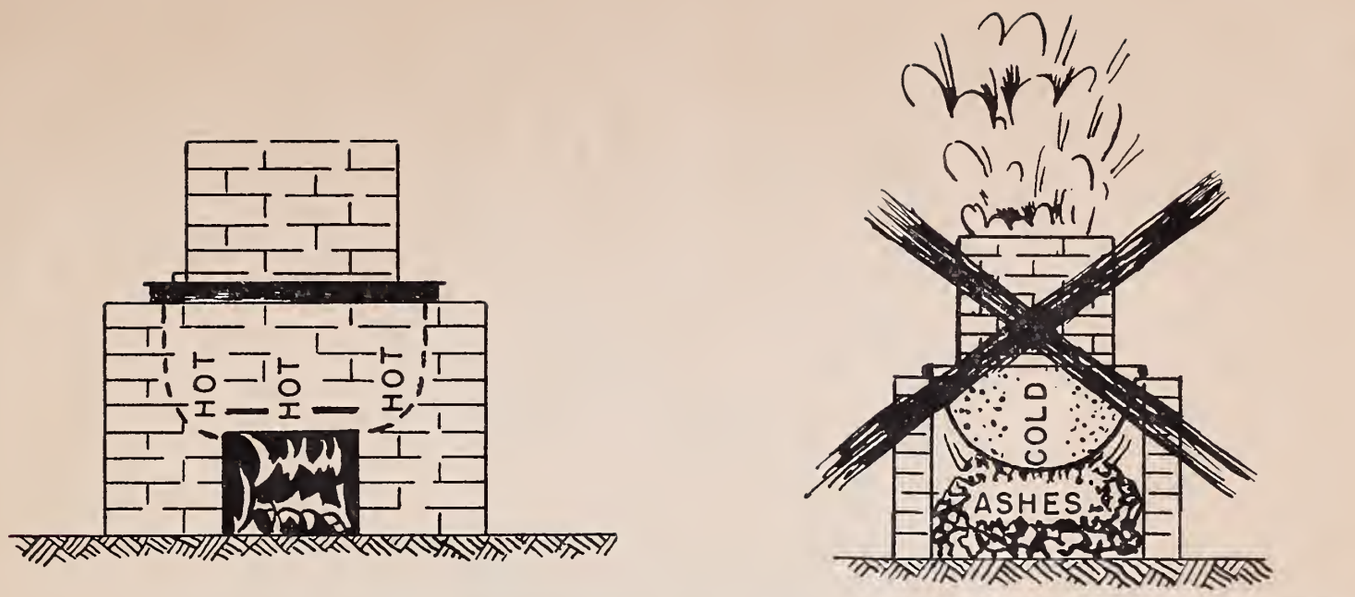

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Figure 4.—Clean ashes daily.

Factory-made direct-fire equipment is of two types, both of which use oil or gas as the source of heat. In one type, the vat that holds the garbage is enclosed in an outer jacket. A burner at the bottom of the vat throws heat into the space between the inner and outer shells. A space of at least 1½ inches is recommended. In the other type, the flames pass through a U-shaped heating pipe set in the bottom of the vat. A grill placed just over the pipe keeps the solid part of the garbage out of direct contact with the hot pipe. However, to prevent charring, enough water must be added to keep the heating pipe covered.

Most factory-made direct-fire equipment can be moved; some vats are mounted on trailers.

With both farm-made and factory-made direct-fire equipment, water evaporates during the heating period. If all the water evaporates and the garbage becomes dry, the vat will overheat, and garbage will stick to the bottom of the vat and may burn. This will ruin the feed and may also ruin the vat. Water acts as a conductor of heat. Garbage surrounded by hot water heats more rapidly than dry garbage (fig. 5). Therefore, enough water must be added to cover most of the garbage. If the garbage floats, fill the vat about one-third full of water.

Steam-injection Equipment

Steam-injection equipment, which heats the garbage by injecting steam into the bottom of the load, is recommended for loads greater than 300 gallons (fig. 6). It is easier to distribute heat evenly over the bottom of a large container by steam-injection heat than by direct-fire heat. In addition to being distributed over the entire bottom of the load, the steam must be injected in such a way that it can bubble up through the entire depth of the garbage.

Many users of steam-injection equipment heat the garbage in their trucks. A truck costs less than a permanently installed vat. But regardless of whether heating is done in a 1-ton

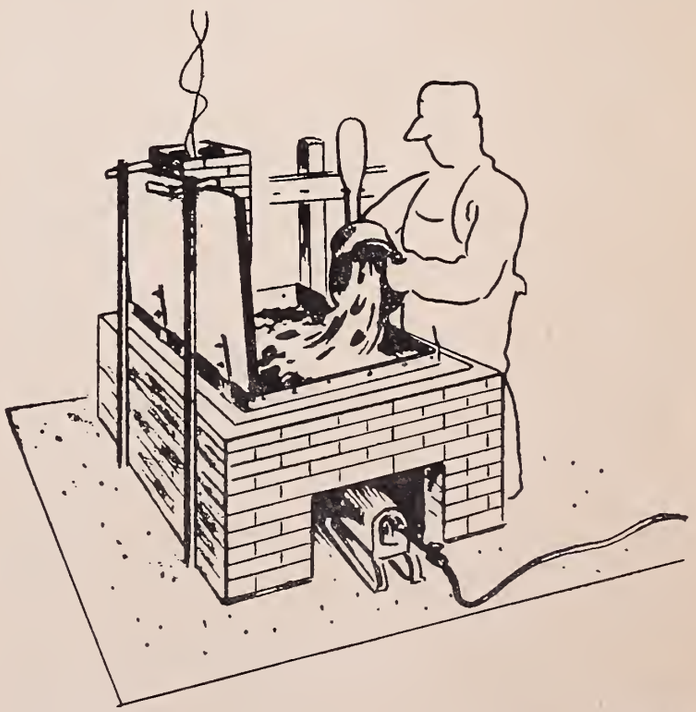

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Figure 5.—Add water to dry garbage.

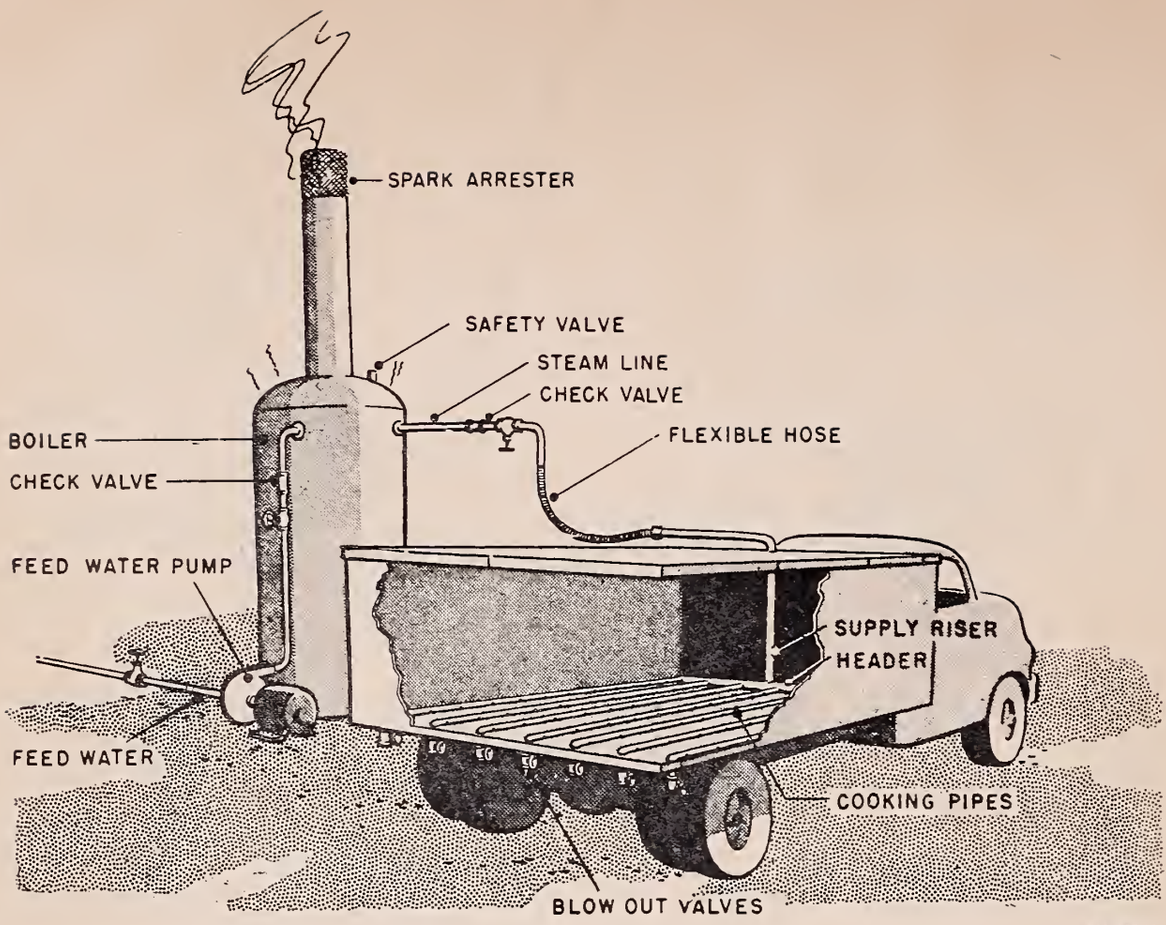


Figure 6.—A steam-injection system.

or a 12-ton truck or in a vat, the same basic principles help to get the desired temperatures.

Steam-heating pipes must be placed in the bottom of the truck body or vat (fig. 7, *A*). If the pipes are placed as much as 2 inches above the bottom, there will be a cold layer between the pipes and the bottom.

In a flat-bottom vat, one pipe must be placed in the corner and as close to the side as possible (fig. 7, *B*). In a round-bottom vat, one pipe must be placed on the bottom. The pipes should be no farther than 14 inches apart and preferably not more than 12 inches. A No. 6 scoop shovel can be used between pipes 12 inches apart on center.

The heating pipes should be welded to the vat or truck body only where they go through it to the blowoff valves. To allow for pipe expansion, there should be at least a half-inch clearance between the end of the vat or truck and the header (fig. 7, *C*).

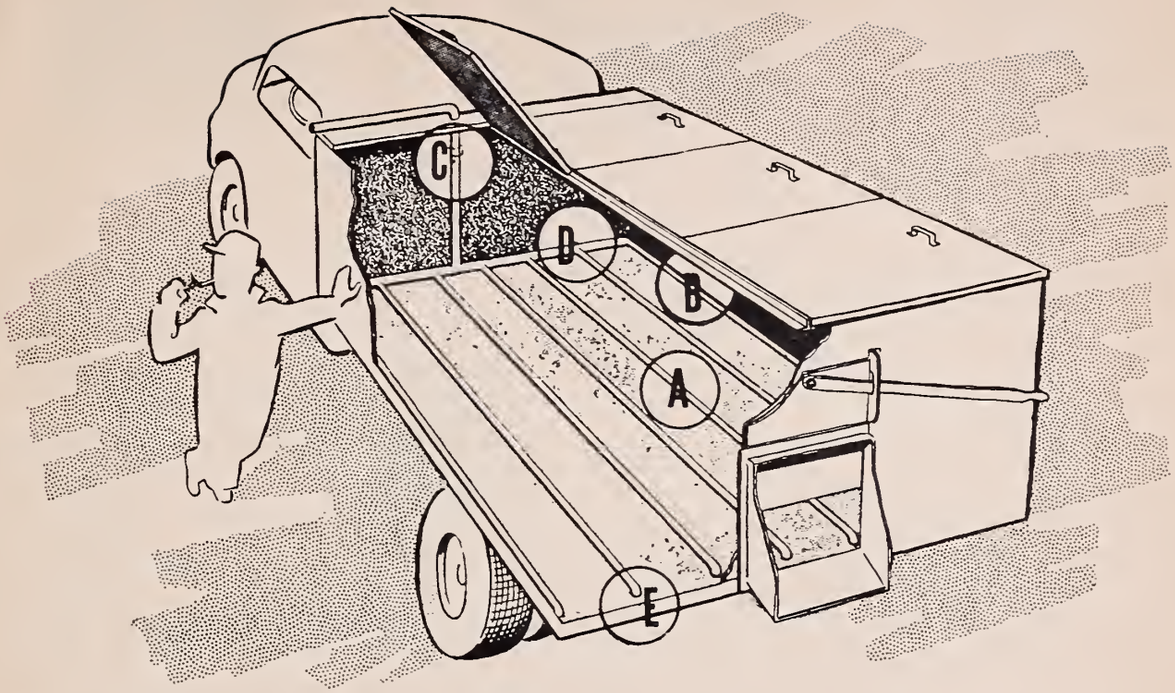
The laterals should be connected to the header by a union (fig. 7, *D*). This permits proper placing of the injector holes and replacement of the pipes.

The pipes should extend through the bottom or end of the truck, and hand valves for blowing out the pipes should be placed on the ends (fig. 7, *E*). This permits steam to reach the ends of the pipes and heat all parts of the load.

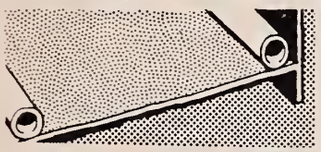
Holes in the pipes (laterals) through which steam is injected into the load must be as small as practicable for proper distribution of pressure in the entire length of pipe. Holes one-sixteenth inch in diameter are desirable. The holes should be staggered and placed 12 inches apart on each side of the pipe, as shown in figure 8. They should be drilled at an angle so the steam is discharged against the bottom of the vat or truck.

One of the most important differences between the direct-fire and steam-injection methods of heating is that the former removes water from the garbage whereas the latter adds water. As the steam cools it changes into water, which remains in the load.

While a boiler is running continuously with a steady pressure, it is adding water from the condensed steam at a rate of approximately 4.2 gallons per hour for each horsepower of the



A Pipes on the bottom of truck or vat.



B Pipe in corner.

C Clamp at top of riser.

D Union along header.

E Blow off valve at end of pipe.

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Figure 7.—Steam pipes in trucks.

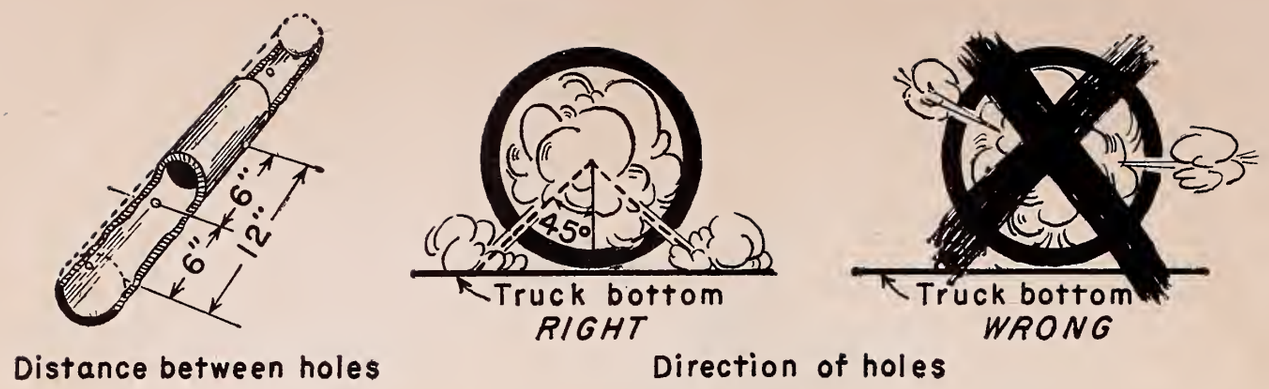

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Figure 8.—Location of holes in pipes.

boiler. For example, during the first hour a 30-horsepower boiler operating continuously will add about 125 gallons of water (fig. 9). If the boiler operates only one-fourth of the time during the second hour, it will add ¼ of 125, or about 31 gallons. The total amount of water added during the 2-hour period will be about 156 gallons. If the boiler is old or a type that produces a lot of water in the steam, this amount may be doubled.

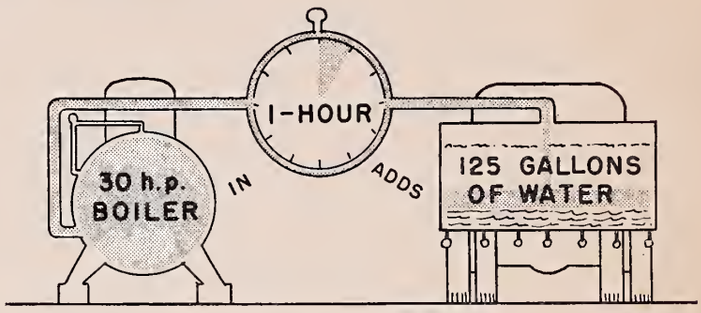

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Figure 9.—30-horsepower boiler adds 125 gallons of water per hour.

HEATING METHODS AND PRECAUTIONS

Good heating methods, as well as good equipment, are important. Good methods help get even temperatures throughout the load, make the feed more palatable, and increase the life of the equipment.

Select the Vat With Care

Select a vat of the proper size. Use of a large vat for a small amount of garbage wastes heat. The vat should be almost filled with garbage during each heating. For larger-than-normal loads, it is advisable to heat twice in a small vat or to use spare equipment.

With steam-injection equipment, the depth of garbage in the vat or truck should never be less than 12 inches (fig. 10). Steam passes through shallow layers of garbage and out the top unused. Shallow layers are especially objectionable if the injector holes are oversized (larger than one-sixteenth inch).

Round-bottom vats, in particular, do not heat properly with either direct-fire or steam-injection equipment when they are underloaded. Also, when steam-injection equipment is used, difficulty may be encountered in unloading round-bottom vats since one injector pipe must be placed in the bottom of the vat. For these reasons, flat-bottom vats are preferable; however, they are more inclined to warp and they may be more difficult to obtain.

The capacity of vats of various dimensions is given in tables 1 and 2. When determining the size of container to obtain, allow for the water that will be added to the garbage (before heating is begun when direct-fire heating is used, and during the heating period when the steam-injection method is used). If the vat is mounted on a truck or trailer chassis, be sure to keep under the legal load limit per axle (fig. 11).

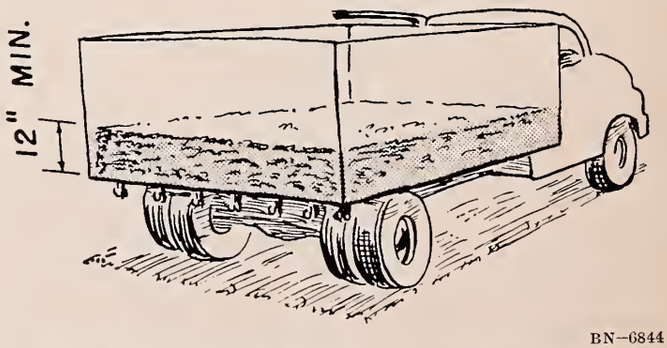

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Figure 10.—Garbage must be at least 12" deep.

TABLE 1.—*Capacity of round vats, per foot of length*

Diameter		Capacity (volume)		Diameter		Capacity (volume)		Diameter		Capacity (volume)	
Feet	*Inches*	*Cubic yards*	*Gallons*	*Feet*	*Inches*	*Cubic yards*	*Gallons*	*Feet*	*Inches*	*Cubic yards*	*Gallons*
3	0	0. 26	53	4	0	0. 47	94	5	0	0. 73	147
3	1	. 28	56	4	1	. 49	98	5	1	. 75	152
3	2	. 29	59	4	2	. 51	102	5	2	. 78	157
3	3	. 31	62	4	3	. 53	106	5	3	. 80	162
3	4	. 32	65	4	4	. 55	110	5	4	. 83	167
3	5	. 34	69	4	5	. 57	115	5	5	. 85	172
3	6	. 36	72	4	6	. 59	119	5	6	. 88	178
3	7	. 37	75	4	7	. 61	123	5	7	. 91	183
3	8	. 39	79	4	8	. 63	128	5	8	. 94	189
3	9	. 41	83	4	9	. 66	133	5	9	. 96	194
3	10	. 43	86	4	10	. 68	137	5	10	. 99	200
3	11	. 45	90	4	11	. 71	142	5	11	1. 02	206

TABLE 2.—*Capacity of rectangular vats, per foot of depth*

Width of vat (feet)	Capacity of vat with a length of—													Width of vat (feet)
	2 feet	2½ feet	3 feet	3½ feet	4 feet	4½ feet	5 feet	5½ feet	6 feet	6½ feet	7 feet	7½ feet	8 feet	
	Gallons	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	
2	30	37	45	52	60	67	75	82	90	97	105	112	120	2
2½	------	47	56	65	75	84	94	103	112	122	131	140	150	2½
3	------	------	67	79	90	101	112	123	135	146	157	168	180	3
3½	------	------	------	92	105	118	131	144	157	170	183	196	209	3½
4	------	------	------	------	120	135	150	165	180	194	209	224	239	4
4½	------	------	------	------	------	151	168	185	202	219	236	252	269	4½
5	------	------	------	------	------	------	187	206	224	243	262	281	299	5
5½	------	------	------	------	------	------	------	226	247	267	288	309	329	5½
6	------	------	------	------	------	------	------	------	269	292	314	337	359	6
6½	------	------	------	------	------	------	------	------	------	316	340	365	389	6½
7	------	------	------	------	------	------	------	------	------	------	367	393	419	7
7½	------	------	------	------	------	------	------	------	------	------	------	421	449	7½
8	------	------	------	------	------	------	------	------	------	------	------	------	479	8

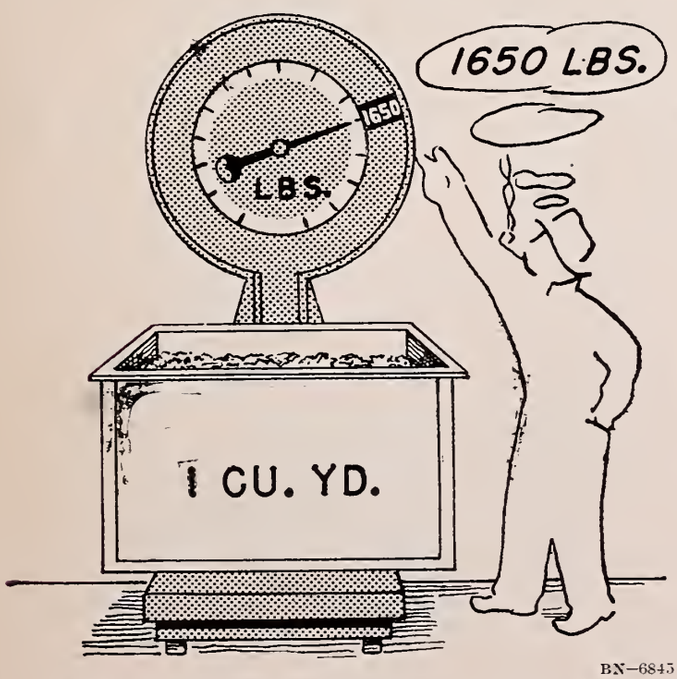

Figure 11.—Weight of 1 cubic yard of garbage.

Stir the Garbage

Stir the garbage to help distribute the heat throughout the load. Stirring reduces the size of the cold regions and destroys steam channels that sometimes form in the load. These channels are objectionable because the steam escapes without losing heat to the garbage. Stirring also helps to keep garbage from sticking to the bottom of the vat.

Because garbage is easier to stir when it is hot than when it is cold and because most of the benefits of stirring occur after some of the garbage is heated, many feeders do not stir during the first 30 minutes of the heating period.

Use of a mechanical agitator with direct-fire equipment (fig. 12) eliminates much of the labor of stirring.

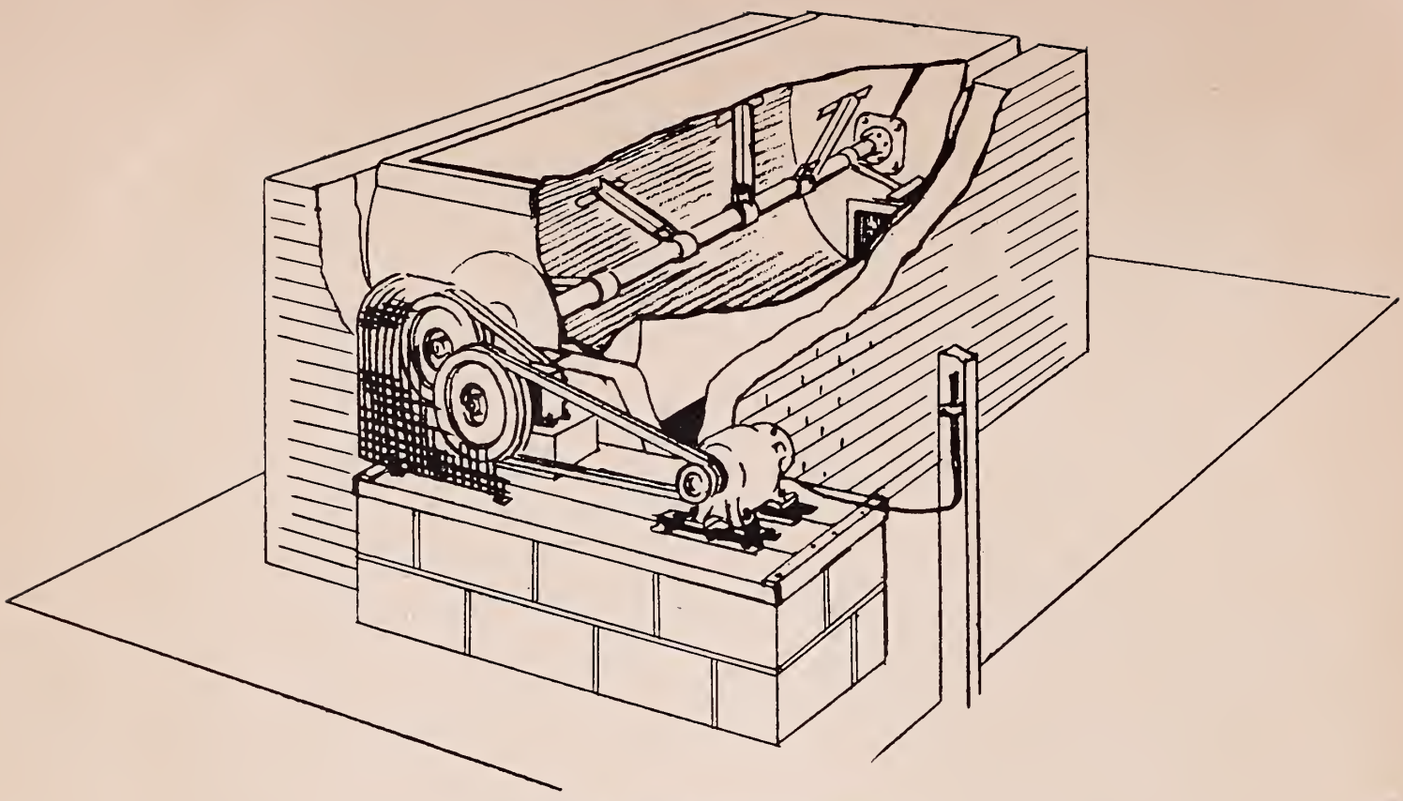

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Figure 12.—Mechanical agitator.

A cylindrical tank mounted on a truck or trailer chassis and equipped with a mechanical agitator is sometimes used with steam-injection equipment. *This type of equipment cannot be used with rough city garbage.* The agitator consists of a solid shaft through the center of the tank, with paddles and paddle arms extending out about every 15 inches along the shaft. Power to turn the shaft is furnished by either a power takeoff from the truck engine or a separate gasoline or electric motor (fig. 13). The clutch for the power mechanism should be equipped with an overload slippage arrangement in case the agitator gets caught.

For efficient agitation, the diameter of the tanker body ordinarily should not exceed 5 feet.

Keep the Load Covered

Keep the load covered during heating, except when stirring. A properly covered load of garbage heats almost as rapidly at the top as at the bottom because the cover holds the steam against the garbage at the top. Since more of the heat goes into the garbage in a covered load, the heating period is shortened and a saving in fuel and labor results (fig. 14).

It is especially important to keep trucks and large vats covered during heating. Large equipment uses fuel faster than small equipment; hence, the saving in fuel, because of the shortened heating period, is correspondingly greater.

Metal covers are preferable. The underside of wooden covers should be lined with sheet metal.

Hot cooking greases quickly ruin rubber gaskets; therefore, gaskets should be made of canvas belting, neoprene, old sections of fire

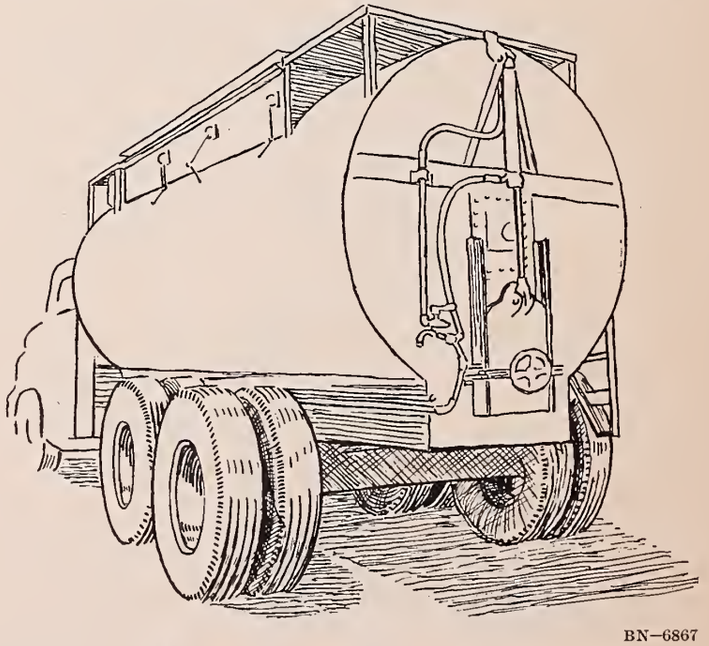

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Figure 13.—Tank-agitator truck.

hose, or similar material. An angle iron should be fastened around the inside edge under the cover to keep the juices from running out from under the cover and down the sides of the vat or truck (fig. 15).

Steam escapes around the edges of the cover. Therefore, the cover should be as small as is practical for loading and unloading, and it should fit tightly at the sides. Also, the cover should have few open joints and should fit down closely over the garbage. Heavy, curved covers that extend some distance above the garbage waste heat.

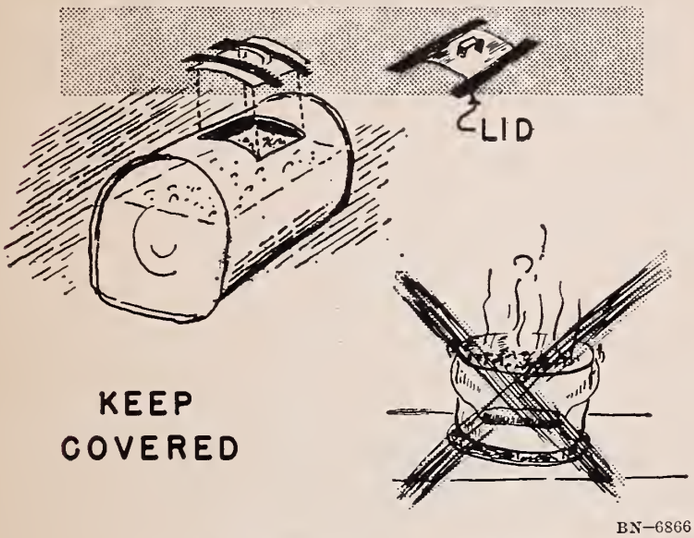

Figure 14.—Keep the load covered.

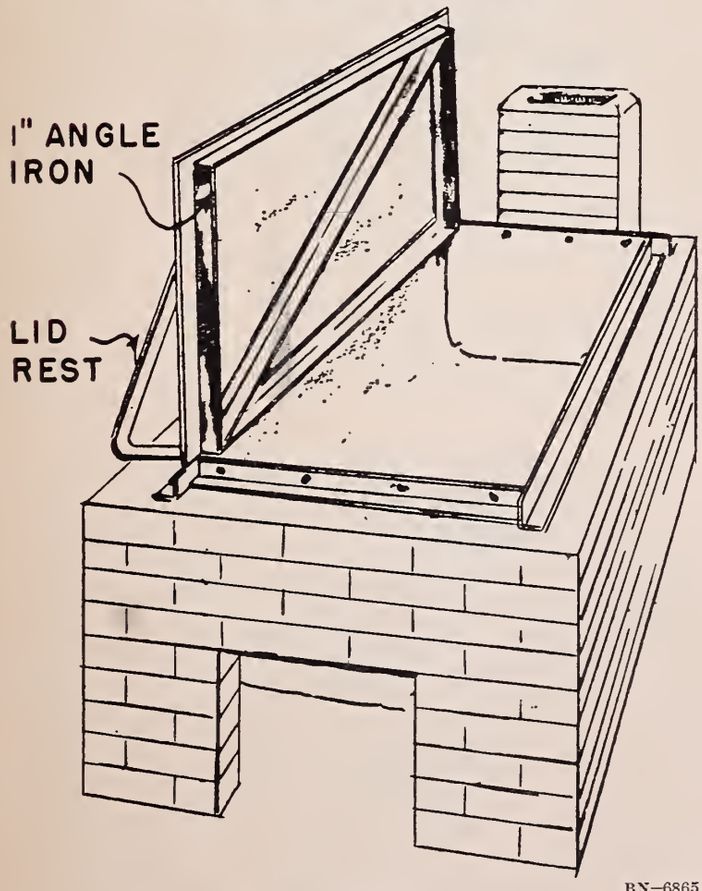

Figure 15.—Angle-iron drip catch.

Covers for large equipment may be difficult to handle. Some feeders who have to manage the cover for a truck or large vat without help have made the cover in several light sections (usually 4 x 8 feet), using 2 x 2 wood frames lined with aluminum. The sections are flanged and slide together. Other feeders use a one-piece cover with hoist (fig. 16).

Tarpaulins are not suitable as covers because steam escapes through them. Also, it is of little value to insulate the cover. In fact, insulation, both on the cover and on the sides of the vat, is actually a disadvantage in warm weather because it delays cooling. Rapid cooling is desirable, especially in warm weather.

Keep the Load Level

Uneven loads of garbage heat unevenly (fig. 17). Keep the vat level.

With direct-fire equipment, the garbage at the shallow end of the vat may char before that at the deeper end has boiled. If a truck is backed up to the vat, a wheel stop should be built in the ground to prevent the truck from knocking the vat over or off balance.

With steam-injection equipment, it is also important to keep the load even to obtain even distribution of heat throughout the load. Steam will escape unused from shallow garbage, where it is needed least, and a correspondingly longer heating period will be required to heat the garbage in the deeper sections of the vat.

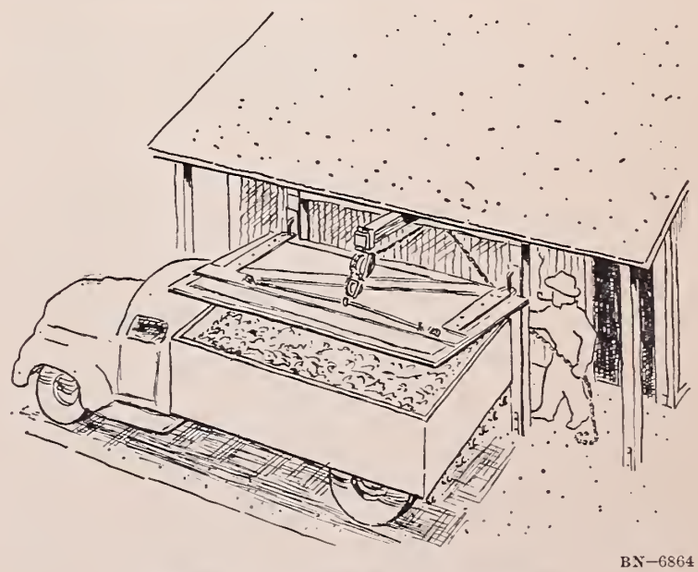

Figure 16.—One-piece lid with hoist.

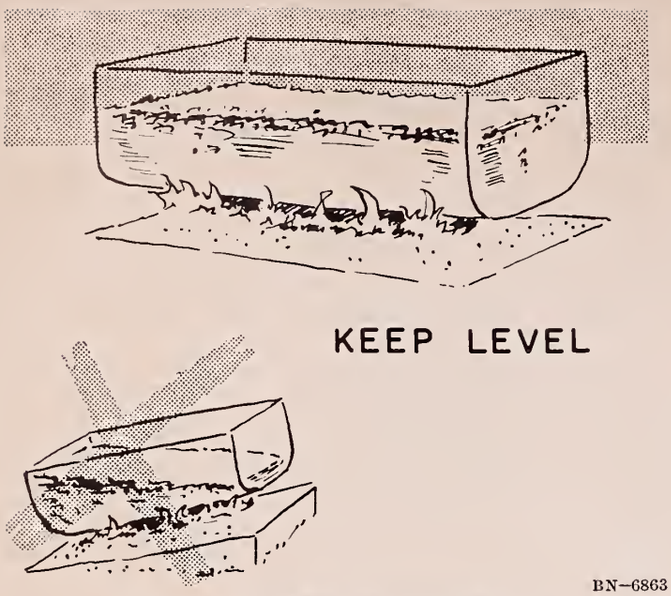

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Figure 17.—Keep the load level.

Apply Heat to the Sides of the Vat

The more heating surface the garbage is in contact with, the shorter the heating period. Therefore, all sides of the vat should be heated.

With direct-fire equipment, a space of at least 1½ inches should be provided on all sides of the vat for the heat. This space should extend up the vat to the garbage level. The vat should be hung on angle irons attached at the top. If the vat is supported from beneath, the support will overheat and sag in the heat.

With steam-injection equipment, one injector pipe should be placed on the bottom as close to the side as possible (fig. 18).

Keep the Equipment Clean

Equipment should be kept clean for efficient operation. A regular time should be established for cleaning, preferably after each heating period.

Any garbage that sticks to the bottom of a vat heated by direct-fire equipment should be cleaned immediately while the vat is still hot (fig. 19). It will be much easier to remove at that time than when the grease has cooled. If stuck garbage is not removed from the vat, it will eventually char. Charred garbage acts as insulation and increases the length of the heating period required. In addition, the vat will corrode under the charred section.

When steam-injection equipment is used, foreign objects such as milk-bottle caps should

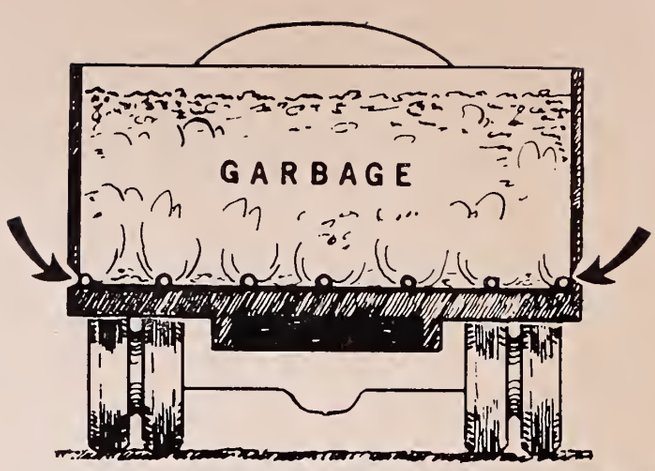

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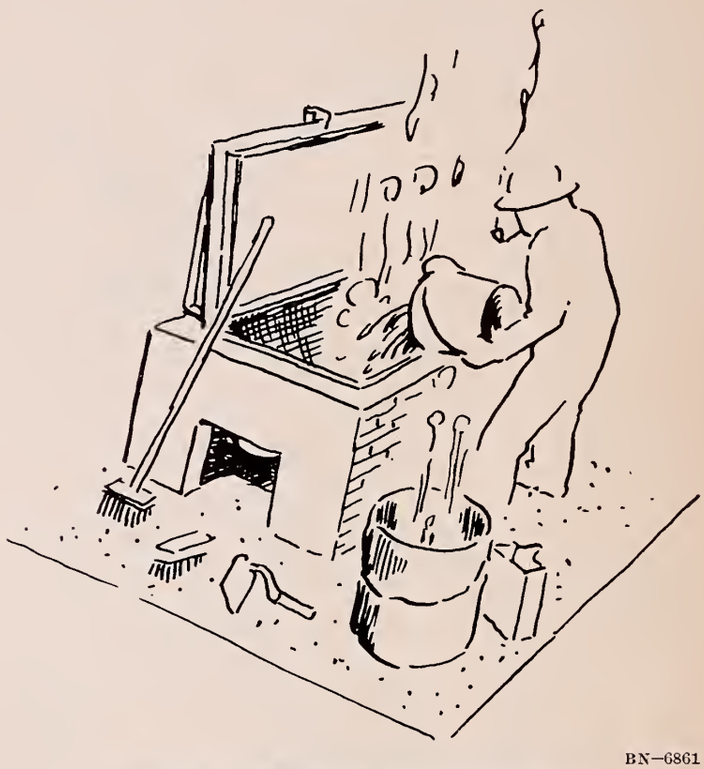
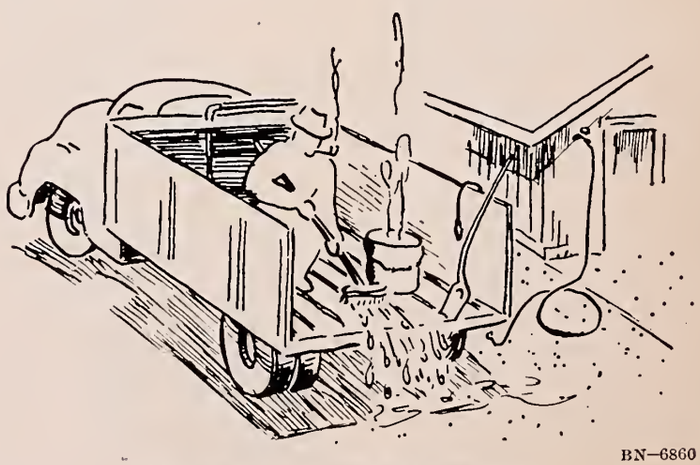
Figure 18.—Place steam pipes on the bottom of the vat and as close to the sides as possible.



BN—6861

Figure 19.—Keep the equipment clean.



BN—6860

Figure 20.—Trucks need cleaning.

be flushed away from the steam outlets (fig. 20).

Equipment should also be kept clean to make it safe. Hot, greasy covers are hard to handle. Garbage spilled around the equipment makes walking a hazard. Special cleaning in addition to the regular cleaning may be necessary if garbage is accidentally spilled on or around the equipment.

In addition to keeping the equipment efficient and safe, cleanliness helps to prevent disease by controlling flies and rats. These disease carriers will not stay where they cannot obtain food.

Keep the Equipment Under Shelter

Protect the equipment from stormy weather. A cold wind blowing against the sides of heating equipment makes the windward side hard to heat. If it is raining or snowing on the equipment, heating is difficult. A roof should be placed over the equipment to keep out rain and snow. It need not be elaborate; in mild climates a simple pole structure is adequate. The roof also provides shelter for the feeder and, if solid fuel is used for heating, keeps the fuel dry.

SPECIAL INSTRUCTIONS FOR HEATING GARBAGE BY STEAM INJECTION

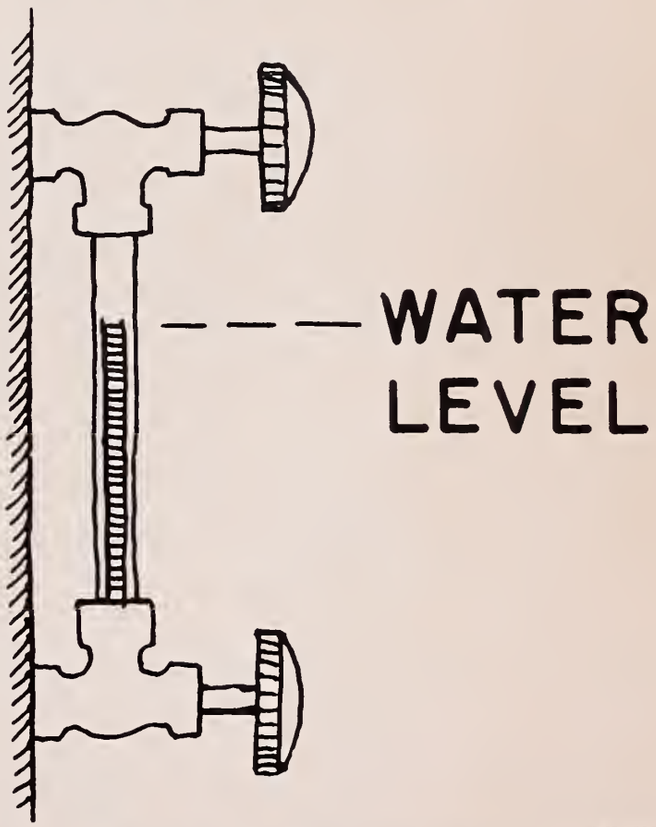
Many people who heat garbage by the steam-injection method, even those with good equipment, do not always use their equipment to best advantage. Good heating methods keep the time required to heat-treat garbage to a minimum and prolong the life of the equipment. The following methods have been found effective:

Step 1—Check the Water Supply

Check to see that there is water in the boiler and that the water-supply system is operative (fig. 21). Enough water should be on hand to supply the boiler during the entire heating period (4.2 gallons per horsepower for each hour of cooking). Start the boiler operating.

Step 2—Blow Out the Scale

After the boiler has reached operating pressure, anchor the flexible hose securely at the open end. Make sure no one is standing near the open end, and open the steam valve wide for 5 seconds to blow out the scale (fig. 22). This helps to prevent scale from collecting in the boiler. In terms of time and shutdown period required, removal of scale from the boiler is probably the most expensive single maintenance operation.

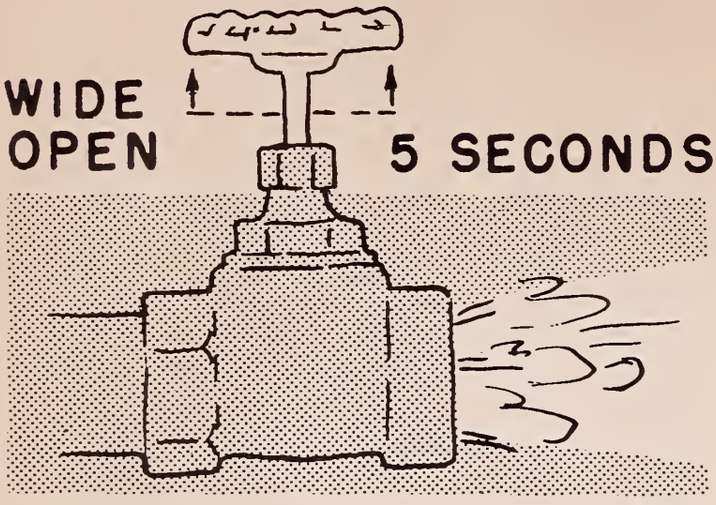


BN—6859

Figure 21.—Check the water supply.

Step 3—Inspect the Injector Pipes

Inspect the flexible hose and coupling to injector pipes and replace any worn hose. Use only high-pressure hose designed for steam. The innerlining of other hose will scale out, collect in the injector pipes, and close the holes



BN–6858

Figure 22.—Blow out the scale.

(fig. 23). The expense of new hose is minor compared with the cost of an accident. Connect the hose securely to the injector grid.

Step 4—Turn Steam Into the Load

Gradually open the steam valve to turn steam into the load. It is normal for the boiler pressure to drop when the valve is first opened, because the cold garbage absorbs steam rapidly (fig. 24). However, to be sure that steam rather than hot water is leaving the boiler, keep the pressure above 5 pounds. On the other hand, it is wasteful to send more steam into the load than the garbage will absorb. Escape of an excessive amount of steam from the load indicates that more steam is going into the garbage than is being absorbed.

Step 5—Blow Out the Injector Pipes

After adjusting the boiler pressure, open the blowoff valves on the injector grid until only steam escapes (fig. 25). Keep the blowoff valves in repair. Failure to use the blowoff valves results in an accumulation of sludge in the pipes, and eventually the steam is unable to force this sludge out.

Step 6—Partly Close the Valve

Hot garbage does not absorb steam as rapidly as cold garbage, and steam that is not absorbed

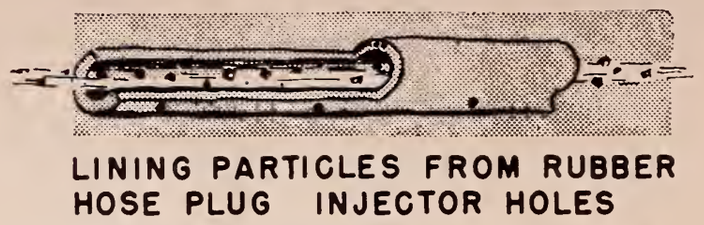


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Figure 23.—Inspect the injector pipes.

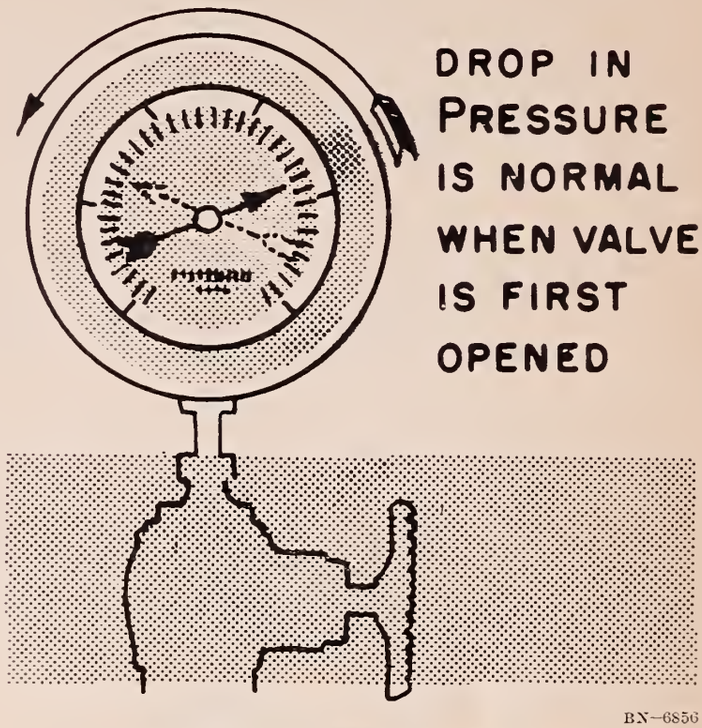

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Figure 24.—Open the steam valve gradually.

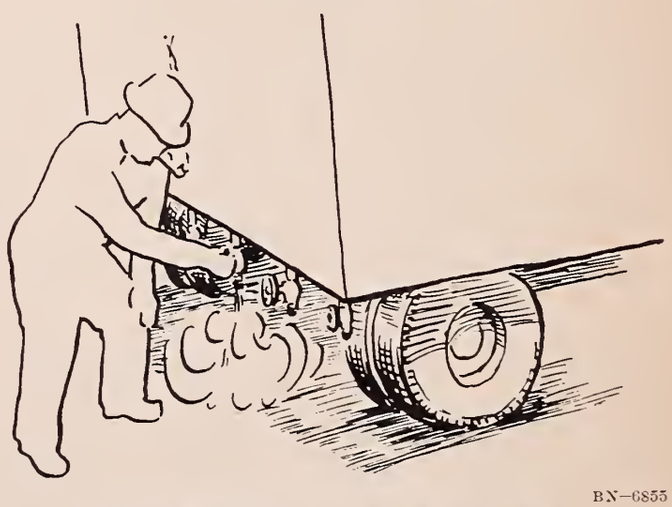

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Figure 25.—Blow out the injector pipes.

will escape the load. Therefore, between 30 minutes and an hour after turning steam into the load, partly close the valve to reduce the amount of steam (fig. 26). Usually the valve may be closed until the opening is only about one-fourth the initial opening.

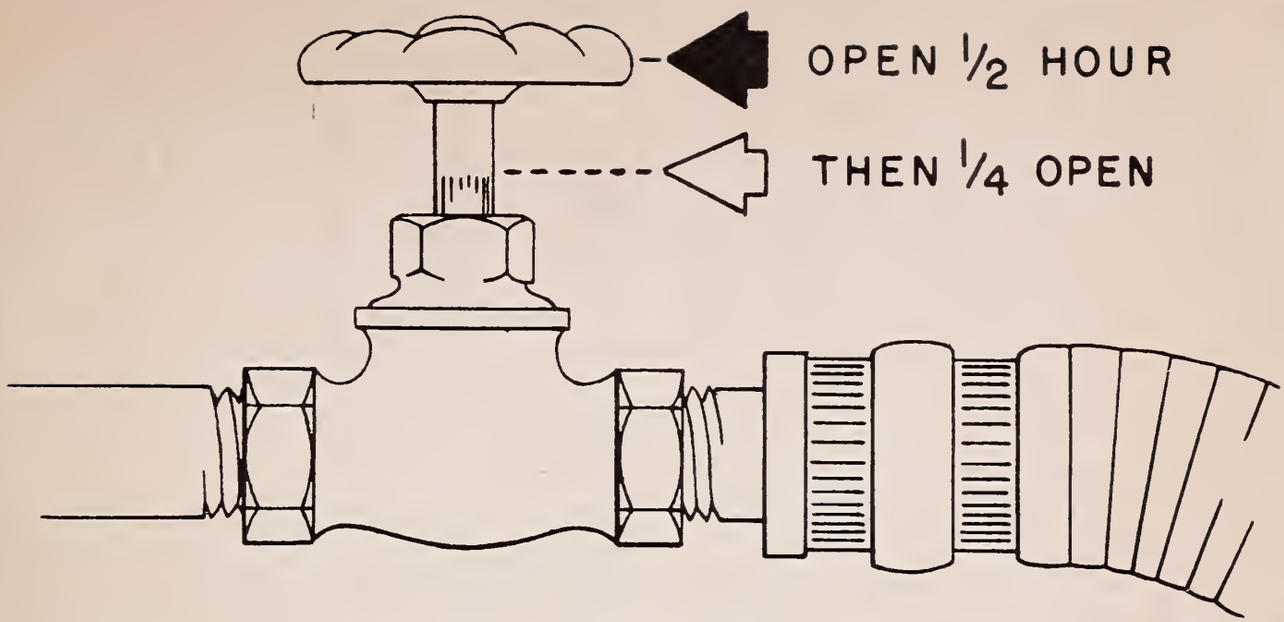

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Figure 26.—After half an hour, partly close the valve.

Step 7—Turn Off the Steam

After the load has boiled 30 minutes, turn off the steam (fig. 27). This will normally be from 2 to 2½ hours after the beginning of operations. (In cold weather it may be desirable to set the boiler on low pressure rather than to turn it off completely.) Wipe oil from the lines and clean the air strainer.

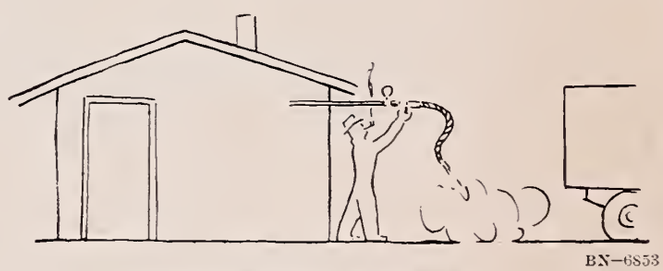

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Figure 27.—Turn off the steam.

Step 8—Disconnect the Injector Pipes

The injector pipes must be disconnected while the boiler is hot (fig. 28), because a vacuum is created in the boiler as it cools. This could suck garbage from the injector grid into the boiler through the partly opened valve. Disconnect the coupling to the injector system. Because of the danger of being burned by steam, disconnect it slowly. Cap the open steam lines to keep out dirt.

BN–6852

Figure 28.—Disconnect the injector pipes slowly.

BOILERS

The amount of steam a boiler produces per hour is one of the important factors to consider in selecting a boiler or generator. The boiler should be large enough to produce enough steam to heat-treat the garbage in a reasonable time.

Steam is measured in terms of weight—that is, ounces or pounds of steam. This has nothing to do with boiler pressure. Boilers that turn 1,000 pounds of water into steam in an hour have the same heat-producing ability whether they are low-pressure or high-pressure boilers. A boiler that turns 1,035 pounds (or about 120 gallons) of water into steam per hour is said to be a 30-horsepower boiler. Most localities require boilers capable of producing at least 8 horsepower for each ton of garbage heat treated (fig. 29), or 6.5 horsepower for each cubic yard. Consult your local plumber or boiler distributor before purchasing a boiler.

Either low-pressure or high-pressure steam may be used to heat-treat garbage. In fact, many feeders who believe they are heating with high-pressure steam may actually be using low pressure in the injector pipes if the valve between the boiler and injector pipes is partly closed (fig. 30).

A large pressure drop in the injector grid can be tolerated better with high-pressure steam than with low-pressure steam (fig. 31). The pressure drop should be kept at a minimum, regardless of the operating pressure. This is best accomplished by keeping the injector holes small.

Steam ordinarily contains some unvaporized water (small invisible droplets of water). Steam that contains a high percentage of these water droplets is called wet steam. *Wet steam is not good for heating garbage.* Most of the heat is released from steam as the steam vapor changes back to water. If the steam is a mixture of 25-percent steam vapor and 75-percent water droplets, only 25 percent is effective in producing heat. The other 75 percent is only hot water, which is added to the load.

BN—6851

Figure 29.—Boilers should have 8 horsepower for each ton of garbage.

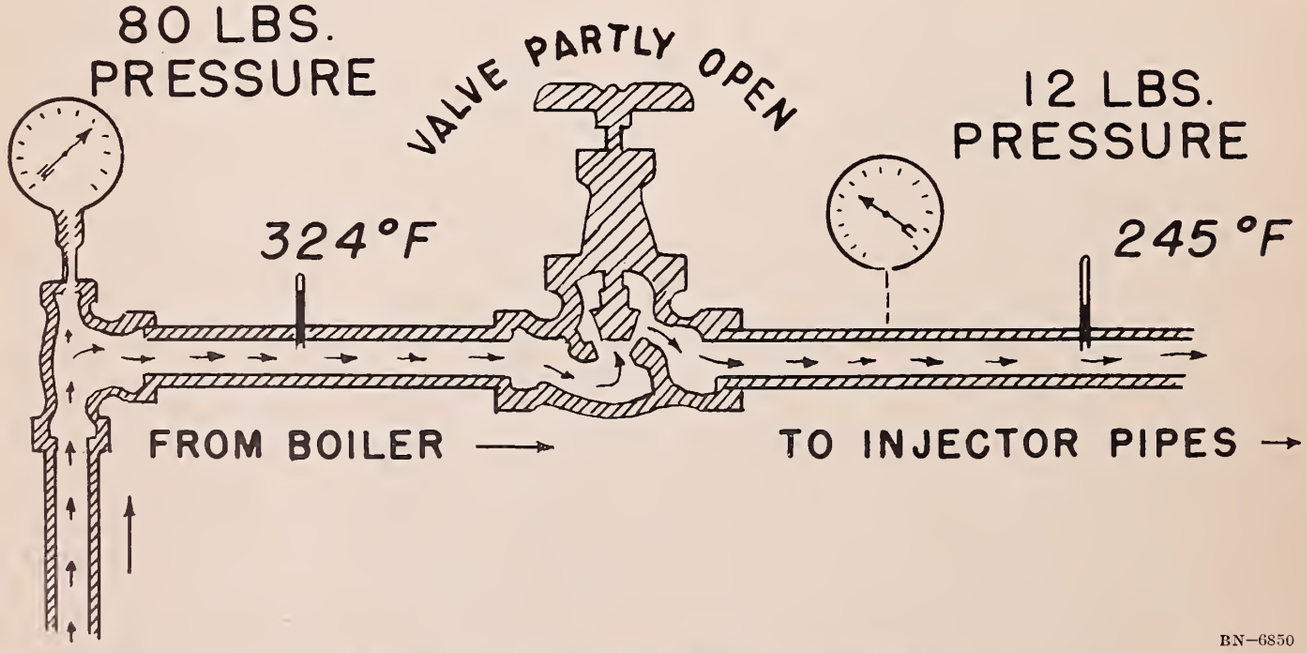

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Figure 30.—Valve partly closed results in low-pressure steam.

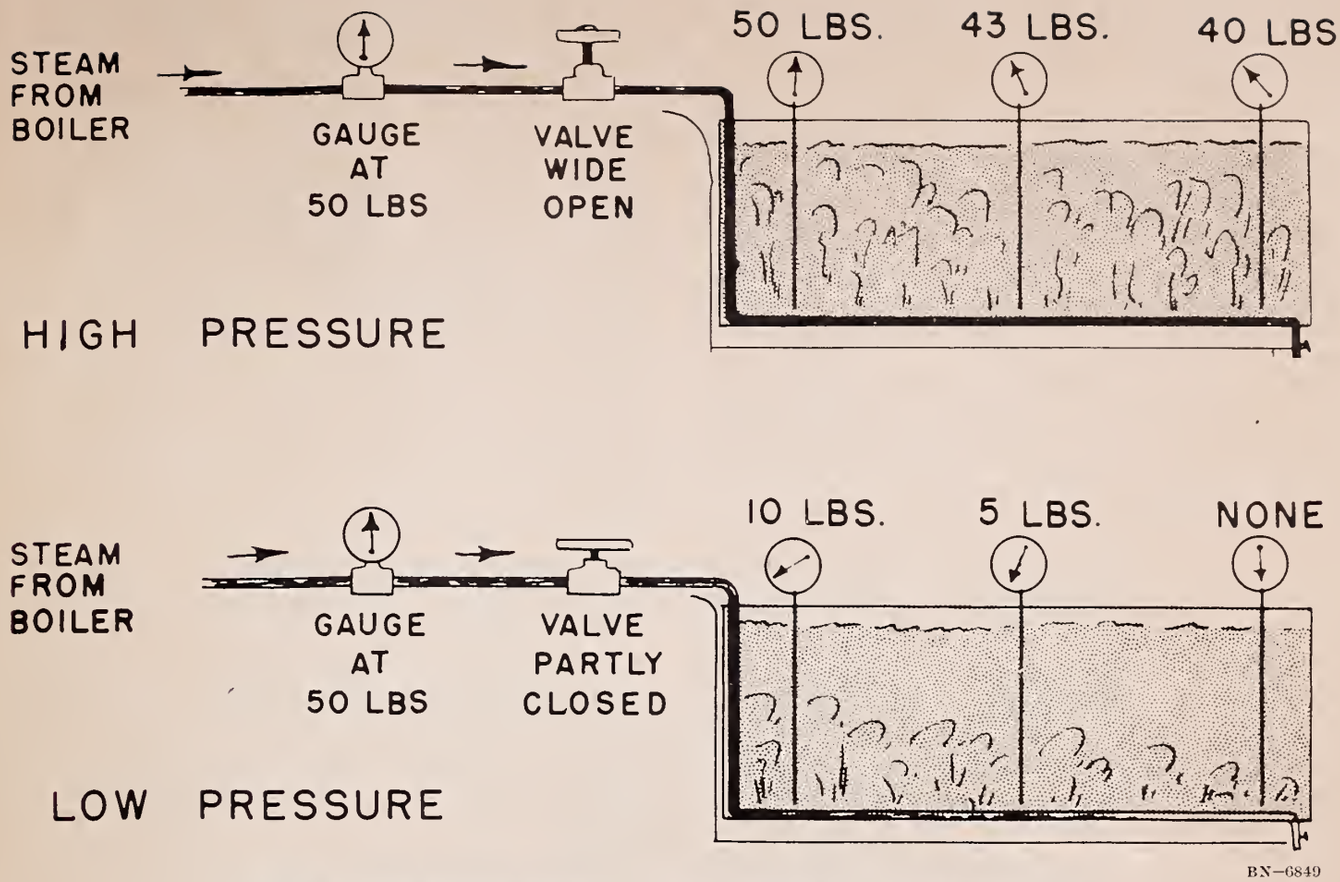

Figure 31.—Effect of pressure drop on high-pressure and low-pressure steam.

CARE OF THE BOILER

Periodic checkups will lengthen the life of the boiler and improve its performance. Points to check include the following:

Keep the Boiler Tubes Clean

Flames carried in the boiler tubes heat the water in the boiler. The heat from the flames must pass through the tubing to reach the water in the boiler. Both soot on the inside (flame side) of the tubing and mineral deposits, called scale, on the outside (water side) of the tubing act as insulation and slow this transfer of heat. These foreign deposits prevent the flames from losing their heat in the boiler, with resulting poor operation.

Soot may be removed from the flame-carrying tubes by cleaning with a stiff wire brush, which usually is supplied by the manufacturer. Addition of chemicals to the water will remove scale and retard its formation. The cost of the chemicals is never a serious matter. Consult your local boiler supplier regarding the chemicals to use in your locality.

Clean the Burner

The burner should be removed from the boiler and cleaned thoroughly when necessary, usually about once a month. Rust and other material that has dropped on the burner should be loosened with a stiff wire brush; then the loosened material should be shaken out of the burner head and mixer. If the burner shows a delayed action, as indicated by a flashback, each burner port should be reamed out with a twist drill the same size as the original hole. The burner should be cleaned with a wire brush at this time.

Check the Valves

The boiler operator should open the hand pull on the safety valve after each heating period to make sure the seat is not sticking. This can be done after the injector grid has been disconnected and while there is still steam pressure. *Warning: Before testing, be sure no one*

is standing where he will be injured by the escaping steam.

Float valves and cutoff valves should be operated manually from time to time to check their operation, especially if the low water cutoff valve is used as a safety device.

A chattering noise in the feed water tank, or hot water in the feed water tank, indicates that steam or hot water is backing up in the tank during the water-pump "off" period. To correct this, remove and clean the check valve and strainer between the pump and boiler. Be sure there is no pressure on these parts before removing them.

Handhole as Cleanout

Many boilers have one or more handholes or washout plugs in the shell of the boiler. Some boilers also have a cleanout at the waterline. These are provided to permit periodic inspection and cleaning of the inner surface of the boiler. If scale forms on the tubes and crown sheets of the boiler, treat the feed water with chemicals to correct the condition. Regular inspection followed by proper treatment when necessary may add greatly to the life of the boiler.

CARE OF INJECTOR PIPES

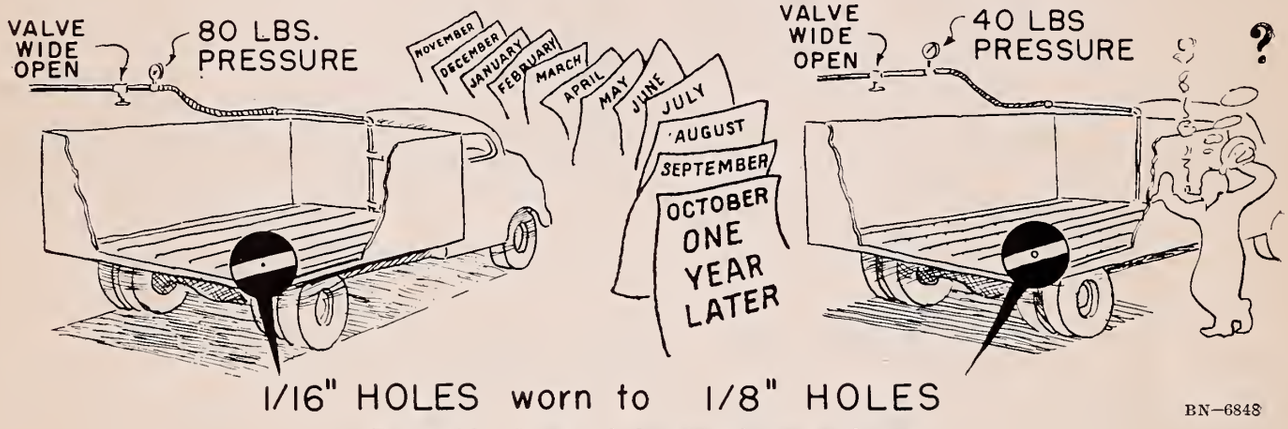

Figure 32.—Injector holes wear larger with use.

The holes in the injector pipes wear larger with use (fig. 32). Large holes are undesirable because they permit more steam to enter the load than the boiler can produce or than the garbage can absorb. When the diameter of a hole has doubled in size, the amount of steam that escapes through the hole has increased fourfold.

Some indications of oversized holes are:

1. To maintain pressure, the boiler valve must be throttled more than in the original setup.
2. The end of the load farthest from the steam inlet is slow to heat.
3. There is excessive bubbling and splattering of garbage immediately above the injector holes (fig. 33).
4. A longer heating period is required.

A survey in 1957 indicated that holes wear out first near the header inlet. Holes wear larger and at about the same rate regardless of

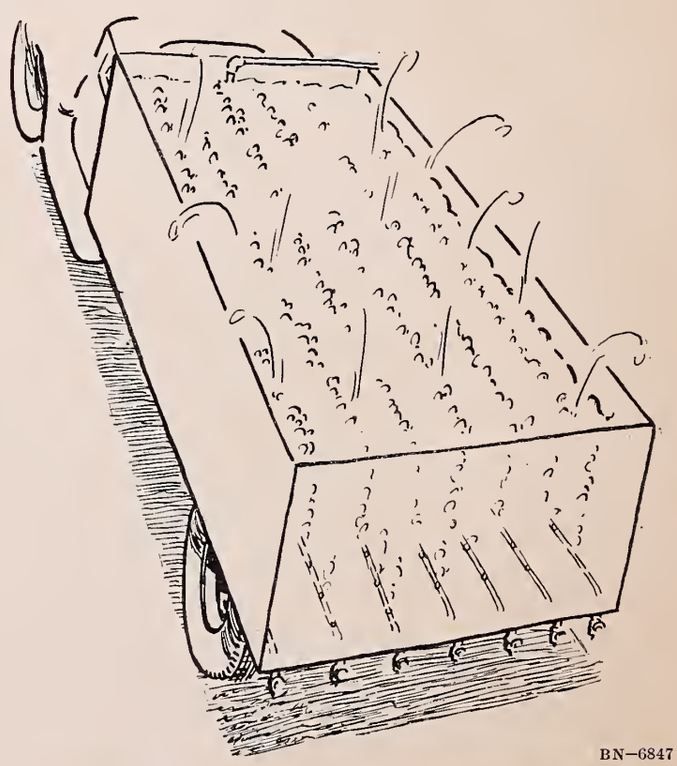

Figure 33.—Garbage splatters above large holes.

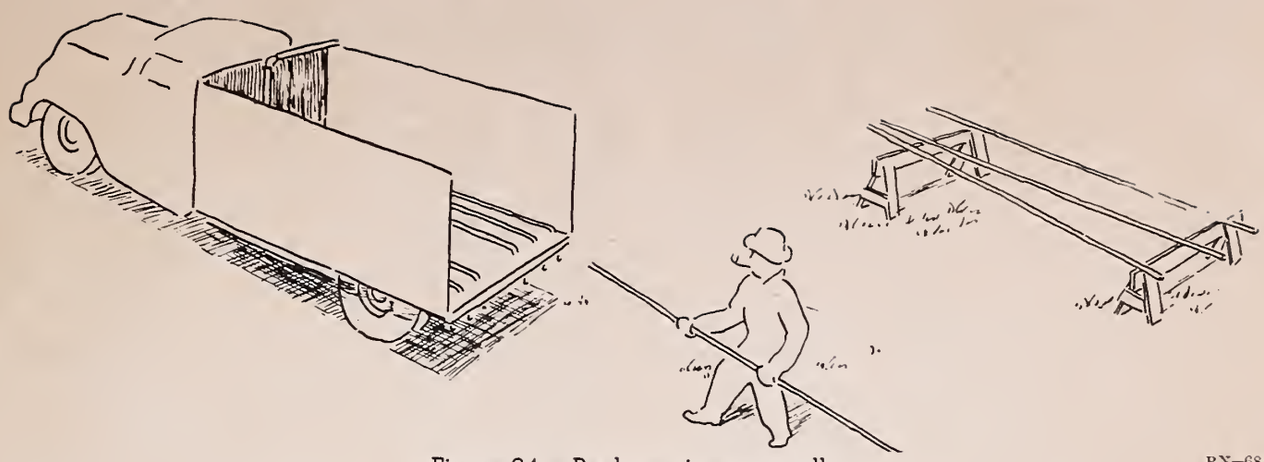

Figure 34.—Replace pipes annually. BN–6846

whether high-pressure or low-pressure steam is used. Also, large holes wear as fast as small holes. These facts make it clear that the initial size of the holes should be small ($\frac{1}{16}$ inch).

Although the injector pipes reported on in the survey were used an average of 800 hours before being replaced, they should be replaced sooner for efficient operation. After 800 hours' use, twice as much steam escaped as through the original holes. One set of pipes was left unchanged for 3,000 hours; by that time, 64 times as much steam escaped as through the original holes.

Therefore, it is recommended that injector pipes be replaced at least once a year (fig. 34). With more than average use, they should be replaced oftener. It is much better economy to replace these pipes than to pay for the extra fuel and labor required to maintain the proper temperature with worn equipment.

COOLING GARBAGE

To hasten cooling of garbage, spread it in thin layers in the feeding troughs several hours before feeding (fig. 35). In one test, cooling garbage in a trough 3 inches deep for half an hour was equivalent to cooling in a vat overnight for 10 hours.

Cooling by adding cold water to the load is unsatisfactory.

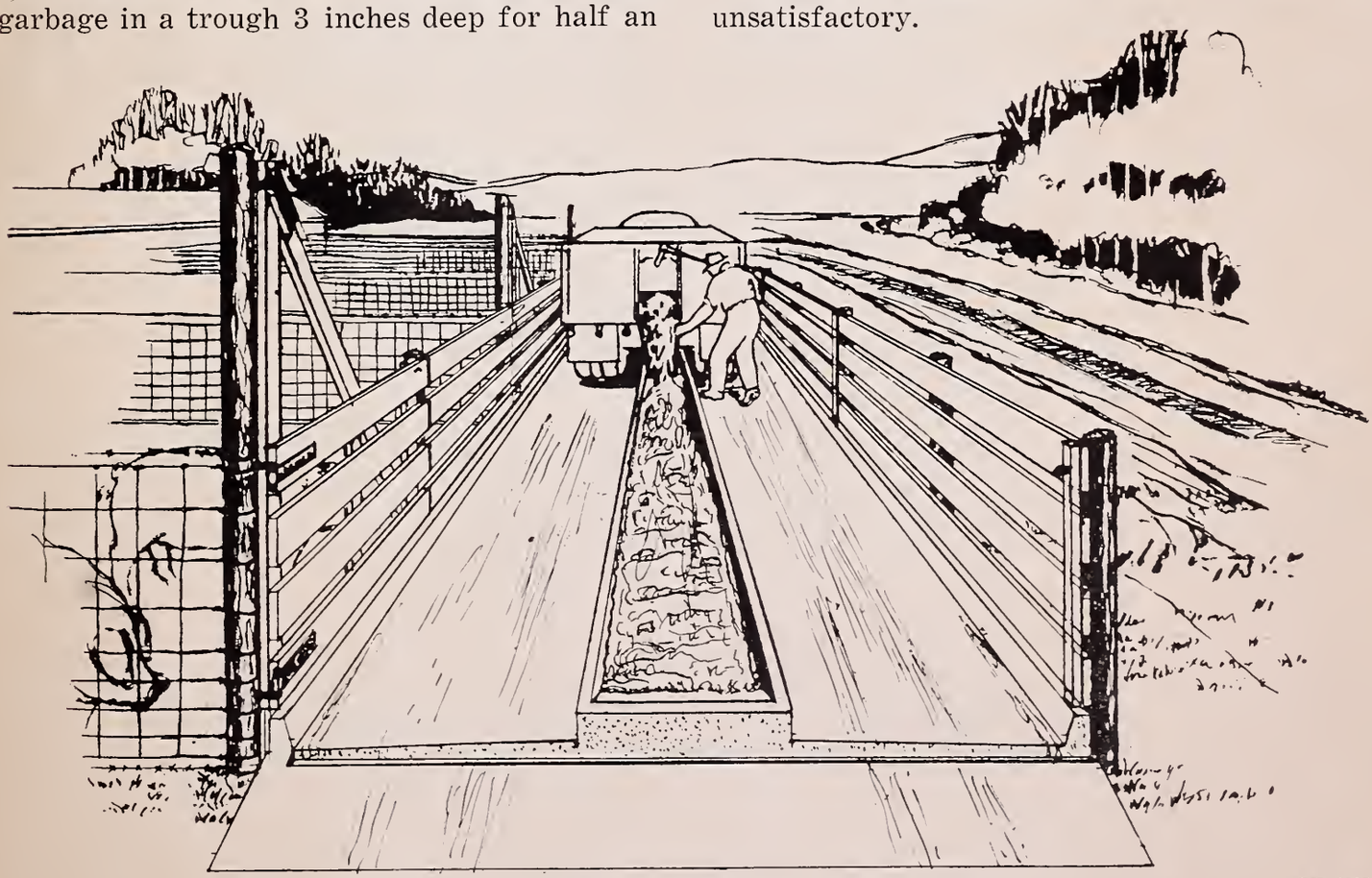

Figure 35.—Hot garbage cools faster in feeding troughs. BN–6837

COST OF HEAT TREATMENT

The cost of heat-treating garbage depends, among other things, on the type and condition of the equipment, the skill and efficiency with which the operator uses the equipment, and the outside temperature.

In general, large loads are heat treated more economically than small loads. However, of more importance than the size of the load is a well-designed, efficiently operated system (including use of tight-fitting covers, correct size of boiler, carefully regulated pressure, and injector holes of the proper size).

A survey in 1956 showed that the average cost of heat-treating garbage in small installations (with boilers of 20 to 50 horsepower) was 56 cents per cubic yard for 13 well-designed, efficiently operated systems as compared with $1.05 for 10 other systems—a difference of 49 cents per cubic yard. Similarly, in large installations (75 to 200 horsepower), the average cost was 45 cents per cubic yard for 6 well-designed, efficiently operated systems, as compared with 92 cents for 4 other systems—a difference of 47 cents per cubic yard.

The initial cost of commercial direct-fire equipment is about the same as steam-injection equipment that will heat the same amount of garbage. However, the cost per ton of garbage heat treated is greater with direct-fire equipment because of the additional labor required.

SANITATION

Proper heat treatment of garbage is a major factor in the reduction of losses from some infectious diseases, but much of the advantage thus gained is lost unless sanitary feeding methods are used. Sanitary methods of feeding are easier if the piggery is built with this in mind. The following points are essential for good hog-farm sanitation:

1. Garbage or similar hog feed should be fed in troughs made of non-absorbent material that can be easily cleaned, washed, and disinfected. Troughs at least 14 inches wide and open at the top will permit easy cleaning.

2. The heating operation should be so located and conducted that swine will have no access to the raw garbage.

3. Feeding areas should be hosed down or dry-cleaned daily to remove any accumulation of inedible materials such as bones, cans, and manure.

4. If washwater and urine are disposed of on the ground, they should be drained in such a way as to prevent them from becoming a nuisance or health hazard.

5. The hog-raising operation should be maintained rodent-free by building ratproof structures, by eliminating rat harborages, by removing their source of food, and by supplemental eradication procedures.

6. The hog-raising operation should be maintained free of flies. This should be achieved basically by good sanitation practices, but insecticides may be used to supplement these practices.

7. Any garbage that is accidentally spilled outside the feeding area should be disposed of promptly. Such garbage attracts rats and provides a breeding place for flies; also, loose pigs may find this feed.

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The U. S. Department of Agriculture has produced a motion picture film entitled "Vesicular Exanthema." For information on it, see your county agent.

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